

## **REMARKS**

### **Status of Claims**

Claims 6-10 were pending in the application.

The original claims have been amended and new claims 11-20 have been added to more clearly define the "parallel offset" feature of the invention, as described in particular at paragraphs [0008]-[0015] of the specification, to better distinguish over the cited prior art. No new matter is introduced by these amendments.

### **Claim Objections**

Claims 7, 8 and 10 are objected to because of the following informalities: In each of claims 7, 8 and 10, "Claim" should read --claim--. Appropriate correction is required.

In response, the claims have been amended.

### **Claim Rejections - 35 USC § 102**

Claims 6, 9 and 10 are rejected under 35 U.S.C. 102(b) as being anticipated by USP 6,234,749 (Hasegawa et al. hereinafter).

According to the Examiner, in re claim 6 Hasegawa et al. disclose a turbo-machine (1), including:

a stator (20, 23), internally coated with a running-in layer (34),

a rotor (10) within the stator (20, 23),

and a device for parallel displacement and *rotation of the rotation axis* of the rotor *about the axis of symmetry* of the stator (col. 5 lines 51-67).

Further, according to the Examiner, in re claim 9 Hasegawa et al. disclose a process for adapting stator (20, 23) and rotor (10) of a turbo-machine (1), wherein a running-in layer (34) is applied upon the stator (20, 23) and this running-in layer (34) is at least partially worn away or abraded by the rotor (10), wherein the rotor (10) is rotated about a rotation axis *displaced parallel to the axis of symmetry* of the stator (col. 5 lines 3-20 and 51-67). In re claim 10

Hasegawa et al. disclose a process according to claim 9, wherein the rotor (10) is introduced rotatingly into the stator.

Applicants respectfully traverse. Where Hasegawa et al displace parallel to the shaft axis, in the present invention the shaft is allowed to be displaced perpendicular to the axis of the shaft – something contrary to the purpose of the bearing, and counter to conventional wisdom.

More specifically, conventionally the axis of symmetry of the stator, and the axis of rotation of the rotor, correspond. However, in the present invention the axis of rotation of the rotor is offset (i.e., loss of coaxiality) as a new way to “run-in” and fit a rotor to a stator.

That is, there is a difference between

- rotation of the rotor about an axis (Hasegawa), with slight *axial* movement of the rotor – without loss of coaxiality (Hasegawa col. 4, line 38; col. 5 line 50) and
- displacing the rotation axis of the rotor *radially* from the axis of symmetry of the stator, and rotating the radially offset rotor axis so that it orbits about the axis of symmetry of the stator – taking advantage of loss of coaxiality.

That is, a line displaced along it's own axis can not be displaced parallel to that axis.

As explained in paragraph [0015] of the specification as published, “parallel displacement and rotation of the rotation axis of the rotor” can be realized by partially or completely removing oil from between shaft and bearing. Since there is a 50 to 500  $\mu\text{m}$  gap between bearing layer and shaft, the so-called bearing play, the partial or complete removal of the oil will allow the shaft, along with its rotation axis, to be displaced, due to centrifugal forces, *parallel to the axis of symmetry of the housing*. As more liquid is removed, so also degree of displacement is correspondingly increased.

Thus, the rotating shaft, when not constrained by the hydrodynamic film, will describe a cylindrical orbit radially wherein at each point in the orbit it is offset from the axis of symmetry of the housing (which axis of symmetry of course remains fixed).

That is, a turbocharger design typically has two bearings or bearing systems for supporting the shaft: one on the compressor-end of the bearing housing; and one on the turbine-end of the bearing housing. Each system has two interfaces: the interface of the rotating shaft on the inner diameter of the floating bearing, and the interface of the outer diameter of the floating bearing on the fixed bore of the bearing housing.

The stiffness and damping capacities of the typical turbocharger double hydrodynamic squeeze film bearings are a compromise between the thickness of the film generated by the rotational speed of the bearing elements and the clearance between the elements.

As explained and illustrated in University of Tennessee at Martin, School of Engineering, **Hydrodynamic Bearings Theory**. Lecture 25 Engineering 473 Machine Design. Hydrodynamic Bearings Theory, (<http://www.scribd.com/doc/11621118/Hydrodynamic-Bearing-Theory>), when a shaft is rotated in a bearing without lubricant, friction will cause the shaft to climb the bearing wall (upper diagram). When lubricant is introduced, the “climbing action” and the viscosity of the fluid will cause lubricant to be drawn around the shaft creating a film between shaft and bearing. Lubricant pressure will more or less center the shaft in the journal bearing.



As explained in DE 19653217 A1 and U.S. Pat. No. 5,185,217 (“similar designs” according to paragraph [0007] of the specification) a journal bearing is, for example, as illustrated in e.g. Fig. 2 of U.S. Pat. Nos. 6,709,160:

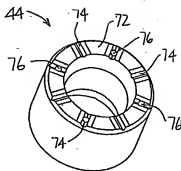


FIG. 2

As explained therein, to achieve longer service life of a turbocharger, a generous flow of oil over the bearings is necessary to minimize metal-to-metal contact between parts and decrease wear of the parts. The '106 patent also discusses Swiss Patent No. 407,665 to Buechi as showing a turbocharger with a pair of floating bearings constrained to float at their respective bearing lands within a center housing (See FIGS. 1 and 2), with bearing clearances between the journal bearing and the shaft, and between the journal bearing and the turbocharger center housing, and explaining that if the clearances between the journal bearing and the shaft, and between the journal bearing and the housing, were large [to provide oil flow adequate to lubricate the thrust bearings], the journal bearings would not provide stable rotational support for the shaft and the turbine and compressor wheels.

These patents thus teach the phenomena of constraint of the rotating shaft by hydrodynamic oil film, and the danger of radial offset or excursion of the rotating shaft in the event of insufficient oil.

The present invention breaks the above rule, and takes advantage of this radial excursion, which is absolutely undesired in an in-service turbocharger, and in fact *induces* this radial shaft excursion during the running in of a rotor relative to a stator.

As described in paragraph [0017] of the present specification as published, by inducing such radial excursions, it is possible with the present invention to omit the conventionally employed abrasive coating on the blade tips of the rotor. The abrasive coating on the blade tips and a finished processing of this friction coating can be dispensed with, on the basis of the free

rotation of the rotor in the stator with the wall of the stator coated over-dimensionally with running-in coating.

Turning back to Hasegawa et al, this reference at best teaches that the shaft is supported such that it can move slightly in the axial direction for suppression of vibration or other reasons (Hasegawa col. 4, line 38; col. 5 line 50). Hasegawa et al have no teaching of the above running-in process (with radial offset of the rotation axis of the rotor from the axis of symmetry of the stator housing) or the product produce by such a process.

Accordingly, withdrawal of the rejection is respectfully requested.

**Claim Rejections - 35 USC § 103**

Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hasegawa et al. in view of USP 6,290,455 (Hemmelgarn et al. hereinafter) and USP 6,203,021 (Wolfla et al. hereinafter).

According to the Examiner, in re claims 7 and 8 Hasegawa et al. disclose all of the limitations except for wherein the rotor blades of the rotor contain aluminum based alloys or iron based alloys or cobalt based alloys or nickel based alloys and the stator contains aluminum based alloys or cast steel (claim 7) and wherein the running-in layer contains AlSi12 or NiCrAl (claim 8).

According to the Examiner, Hemmelgarn et al. teach an aluminum alloy casing (stator) and Wolfla et al. teach gas turbine engine components (this includes rotor blades) of iron, cobalt or nickel based alloys (col. 2 lines 64-66) as well as an abradable layer (running- in layer) of a NiCrAl alloy (col. 2 line 66 - col. 3 line 5).

In response, Applicants point out that the primary reference does not teach displacing the rotation axis of the rotor *radially* from the axis of symmetry of the stator, and rotating the radially offset rotor axis so that it orbits about the axis of symmetry of the stator.

The secondary references do not remedy the deficiency in the primary reference.

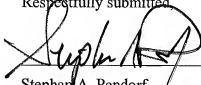
Thus, the combination of references does not reach the present invention.

Withdrawal of the rejection is respectfully requested.

**Should further issues remain prior to allowance, the Examiner is respectfully requested to contact the undersigned at the indicated telephone number.**

The Commissioner is hereby authorized to charge any fees which may be required at any time during the prosecution of this application without specific authorization, or credit any overpayment, to Deposit Account Number 16-0877.

Respectfully submitted,

  
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